A hydrous mantle transition zone indicated by ringwoodite included within diamond

D.G. PEARSON[1], F.E. BRENKER[2], F. NESTOLA[3], J.C.R. MCNEILL[4], L. NASDALA[5], M.T. HUTCHISON[6], S. MATVEEV[1], K. MATHER[4], G. SILVERSMIT[7], S. SCHMITZ[2], B. VEKEMANS[7] AND L. VINCZE[7]

[1]University of Alberta, Canada, (gdpearso@ualberta.ca)
[2]Goethe University, Germany (f.brenker@em.uni-frankfurt.de)
[3]Università di Padova, Italy, (fabrizio.nestola@unipd.it)
[4]Durham University, UK, (k.a.mather@durham.ac.uk)
[5]University of Vienna, Austria, (lutz.nasdala@univie.ac.at)
[6]Trigon GeoServices Ltd, USA, (mth@trigon-gs.com)
[7]Ghent University, Belgium, laszlo.(vincze@ugent.be)

Theory and experiments have shown that wheras the water storage capacity of olivine-dominated shallow mantle is limited, the Earth's Transition Zone (TZ) could be a major repository for water, due to the ability of the higher-pressure polymorphs of olivine - wadsleyite and ringwoodite - to host up to ~2.5wt. % H_2O. Despite experimental demonstration of the water-bearing capacity of these phases, geophysical probes such as electrical conductivity have provided conflicting results, and the issue of whether the TZ contains abundant water remains highly controversial. In this study we report X-ray diffraction, Raman and infra-red spectroscopic evidence for the first terrestrial occurrence of any higher pressure polymorph of olivine: ringwoodite, included in a diamond from Juína, Brazil. The ringwoodite occurs with a Ca-walstromite phase that we interpret to be retrogressed Ca-silicate perovskite. The most likely interpretation of this two-phase assemblage is that it represents a partially retrogressed portion of a somewhat Fe-rich peridotitic mantle, in which hydrous ringwoodite, and former $CaSiO_3$- perovskite co-existed above 15GPa. The ringwoodite has a Mg# of ~ 75, suggesting that it may be mantle hybrised with a more fertile component such as subducted oceanic crust. The water-rich nature of this inclusion (~1.5 wt%), along with the preservation of ringwoodite, is the first direct evidence that, at least locally, the TZ is hydrous, to about 1 wt%. As well as being in agreement with recent magnetotelluric estimates of the TZ water content, this amount of water helps to reconcile measured TZ seismic velocities with those predicted from lab experiments. The finding also indicates that some kimberlites must have their primary sources in this deep mantle region.